A Preliminary Assessment of Fish Lake

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SECTION 1. INTRODUCTION

This report presents the results of a preliminary assessment of Fish Lake by International Science & Technology , Inc. (IS&T) for the Michiana Fish Lake Association. The purpose of this survey was to provide the information necessary to characterize water quality conditions in the lake and its major tributary, and to make recommendations designed to improve the overall quality of the lake. Suggestions for state funding of restoration activities are also provided.

1.1 FISH LAKE

Fish Lake is located along the Indiana-Michigan border, northwest of the town of Shipshewana, Indiana. The majority of the lake is located in White Pigeon Township, St. Joseph County, Michigan. The southern one-third of the lake, as well as the primary inlet and the lake outlet, are located in VanBuren Township, LaGrange County, Indiana. Fish Lake has a surface area of 139 acres, a volume of 2,556 acre-feet, a maximum depth of 57 feet (IDNR, 1958), and a mean depth of 18 feet. Single family residences entirely surround the lake, with the exception of the south shore. Approximately 75% of the residences are occupied year round (B. Giles, pers. comm., Michiana Fish Lake Association, 1990). Fish Lake is used primarily for recreational purposes. Fishing is the primary attraction, although the lake is also open to water skiing.

The Fish Lake watershed is predominantly agricultural, with a major transportation route (Interstate 80) located just south of the lake. The major tributary to the lake is Fetch Ditch, which drains the Indiana portion of the watershed, and enters the lake on the southeast side at the Michigan-Indiana state border. There are also two intermittent tributaries to the lake. The first tributary receives overland runoff from adjacent farm fields, and enters the lake via a culvert located along the north shore. The second intermittent tributary is located on the east side of Fish Lake, north of Fetch Ditch. Both tributaries are noted to produce runoff primarily in the spring. Aerial photography from 1957 (IDNR, 1958) shows Fetch Ditch entering Fish Lake at the site of the second intermittent tributary. It is possible that the Fetch Ditch water course has been altered since 1957 so as to enter Fish Lake south of the original inlet. Should this be the case, the second intermittent tributary would then be a remnant of the original Fetch Ditch. The Fish Lake outlet is located on the southwest shore, within the state of Indiana. The outlet structure consists of a fixed concrete sill with removable boards.

1.2 NATURE OF THE PROBLEM

Deteriorating water quality in the lake has been a growing concern among the members of the Michiana Fish Lake Association. Water clarity during the summer of 1989 was reported to have been "poor", with the runoff entering the lake through Fetch Ditch described as "black tar" (P. Wysong, pers. comm., Michiana Fish Lake Association, 1990). Macrophyte growth within the photic zone of the lake comm., Michiana Fish Lake Association, 1990). Macrophyte growth within the photic zone of the lake has been heavy, with mats of filamentous algae interspersed throughout the macrophyte beds. In previous years, macrophyte control has been accomplished through the use of herbicides and weed harvesting (P. Wysong, pers. comm., Michiana Fish Lake Association, 1990). During the late spring of 1990, heavy mats of filamentous algae covered the majority of the surface area of the lake (Figure 1). Macrophyte growth during the summer of 1990 has not been as great as in previous years.

1.3 STUDY OBJECTIVES

The objective of this preliminary assessment was to characterize the current conditions in the lake and watershed with respect to water quality, and recommend strategies designed to improve the overall quality of this resource. IS&T is aware of the on-going monitoring conducted in cooperation with the LaGrange County Health Department. Analysis of the data collected by LaGrange County however, was not a part of this preliminary assessment.

Two phases of activity were required to meet the project objective. The first phase involved collection of field data. Water samples, and in-situ chemical and physical data were collected from the lake and Fetch Ditch. These data provided the most recent evaluation of conditions in the lake. The second phase involved a visual watershed reconnaissance. Land uses which might contribute excessive sediment and/or nutrient loading to Fish Lake were noted.

Based on the information gathered, recommendations designed to address the problems observed in this study were developed. The methods used in each phase of the project and the results of the study are presented in the sections that follow.

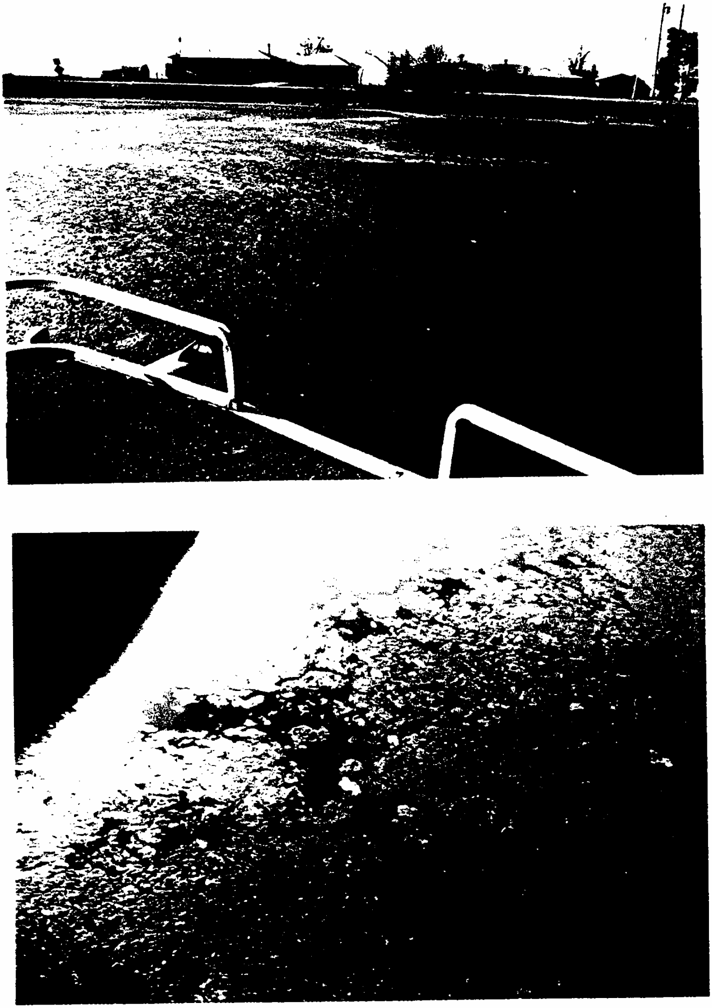


Figure 1. Filamentous algae on Fish Lake during spring 1990. (Photo courtesy of B. Giles, Michiana Fish Lake Assoc.)

SECTION 2. METHODS

2.1 IN-SITU MEASUREMENTS

In-situ water quality and water samples were collected on 20 June 1990 at one in-lake station located at the deepest part of the lake. In-situ profile measurements of temperature, dissolved oxygen and pH were made using a Hydrolab "Surveyor II" Environmental Data System. Measurements were recorded at the surface, and at regular (i.e., two foot) intervals to the lake bottom. Secchi disk transparency was measured on the shaded side of the boat. The Secchi disk was lowered until it disappeared, and then raised until it reappeared. The average of these two depths was reported as the Secchi disk depth.

2.2 CHEMICAL MEASUREMENTS

Water samples were collected at the water surface and at a depth of 51 feet using a 6-L (6.6 quart) vertical Van Dorn water sampler. All in-lake water samples were collected at the same location as the in-situ data. Samples for nutrient (i.e., total phosphorus and Total Kjeldahl Nitrogen) analysis were poured directly from the Van Dorn into a clean 4-L Cubitainer container. A separate aliquot was also collected from the surface for chlorophyll analysis. All samples were immediately placed in coolers and stored at $4^{o}C$ prior to shipment to the analytical laboratory at Purdue University. Table 1 lists the analytes measured in the water samples and the methods used to conduct the analyses.

Table 1. Chemical parameters used in evaluating the Fish Lake water samples.

PARAMETER	REFERENCE
Chlorophyll a (Chla)	Standard Methods, 16th edition
Total Phosphorus (TP)	Standard Methods, 16th edition
Total Kjeldahl Nitrogen (TKN)	Standard Methods, 16th edition

In addition to the water samples, quality assurance samples were also collected in the field and included in shipment to the analytical laboratory. These samples consisted of duplicate samples from each depth. The duplicate sample, obtained from a second water sample collection at each depth, provided a measure of variability within the water column.

A water quality sample was also collected from the mouth of Fetch Ditch on 20 June 1990. One grab sample was collected from this tributary by immersing a clean, rinsed and labeled 4-L Cubitainer into the tributary outflow at mid-channel. The sample was placed in a cooler and stored at $4^{O}C$ prior to shipment to the analytical laboratory. With the exception of chlorophyll, this sample was also analyzed for the parameters listed in Table 1.

2.3 WATERSHED SURVEY

Characterization of the current conditions in the Fish Lake watershed was oriented toward identifying the principal sources of sediment and nutrient loading within the Fetch Ditch drainage basin. Major land use patterns were identified by visual reconnaissance using USGS topographic maps (1:24,000 scale).

SECTION 3. RESULTS AND DISCUSSION

This investigation included the collection of in-situ, chemical and biological measurements from Fish Lake and Fetch Ditch. These data were used to summarize the lake conditions on the day of sampling, and to assess its current trophic state.

3.1 IN-SITU MEASUREMENTS

In-situ water quality measurements are presented in Table 2 and Figures 2a-2c. These data

Table 2. Fish Lake in-situ water quality measurements. (20 June 1990)

DEPTH (ft)	TEMP (C)	DO (mg/L)	pH	SECCHI DEPTH (m)
0	24.0	7.84	8.6	1.75
4	24.0	7.61	8.5	
6	24.0	7.30	8.5	
8	24.8	6.55	8.5	
10	23.3	6.41	8.4	
12	22.8	5.85	8.4	
14	18.5	5.20	8.4	
16	17.9	4.90	8.4	
18	17.9	4.90	8.4	
20	17.2	4.73	8.4	
22	16.3	4.79	8.3	
24	15.4	4.86	8.2	
26	14.5	3.95	8.0	
28	13.5	3.45	8.0	
30	12.3	2.58	8.0	
31	10.6	0.73	7.8	
33	10.2	0.21	7.8	
34	9.6	0.11	7.8	
36	9.3	0.05	7.7	
38	9.0	0.05	7.7	
41	8.7	0.05	7.7	
43	8.5	0.12	7.8	
45	8.1	0.06	7.7	
48	8.0	0.06	7.6	
50	7.7	0.06	7.6	
52	7.7	0.06	7.6	
54	7.6	0.06	7.5	
55	7.6	0.06	7.5	

Figure 2a.

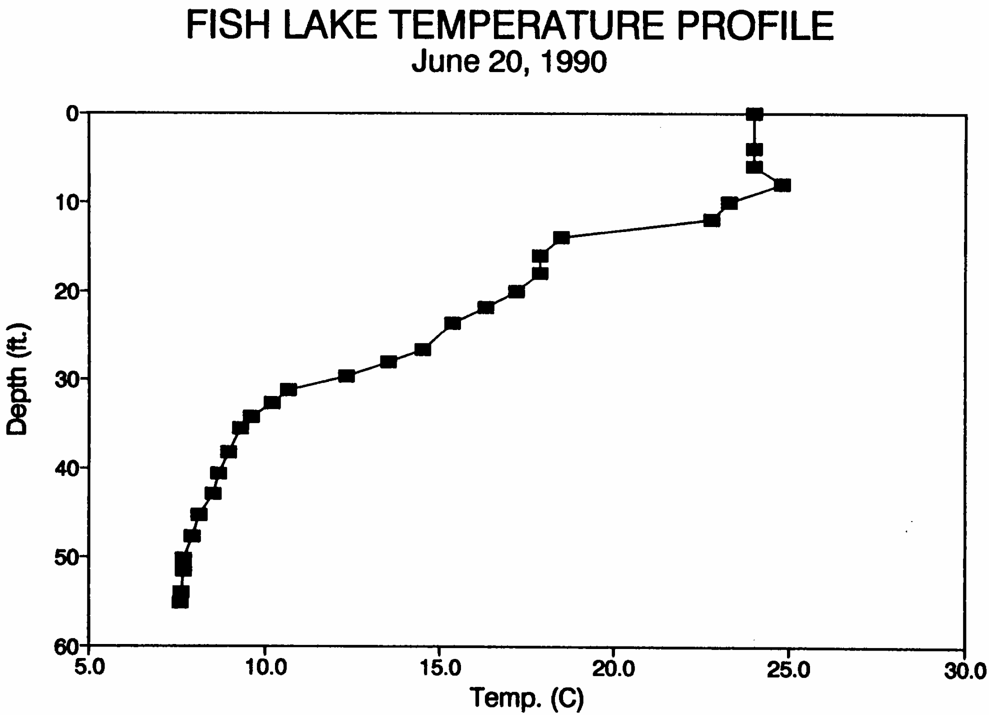

FISH LAKE TEMPERATURE PROFILE
June 20, 1990
Depth (ft.)
Temp. (C)
0
10
20
30
40
50
60
5.0
10.0
15.0
20.0
25.0
30.0

Figure 2b.

FISH LAKE DO PROFILE
June 20, 1990

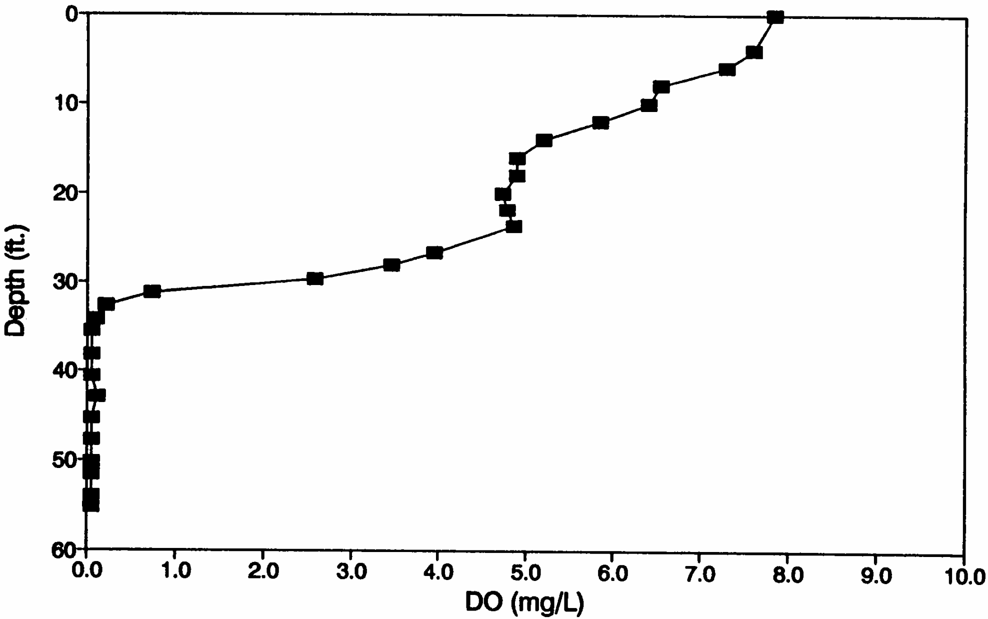
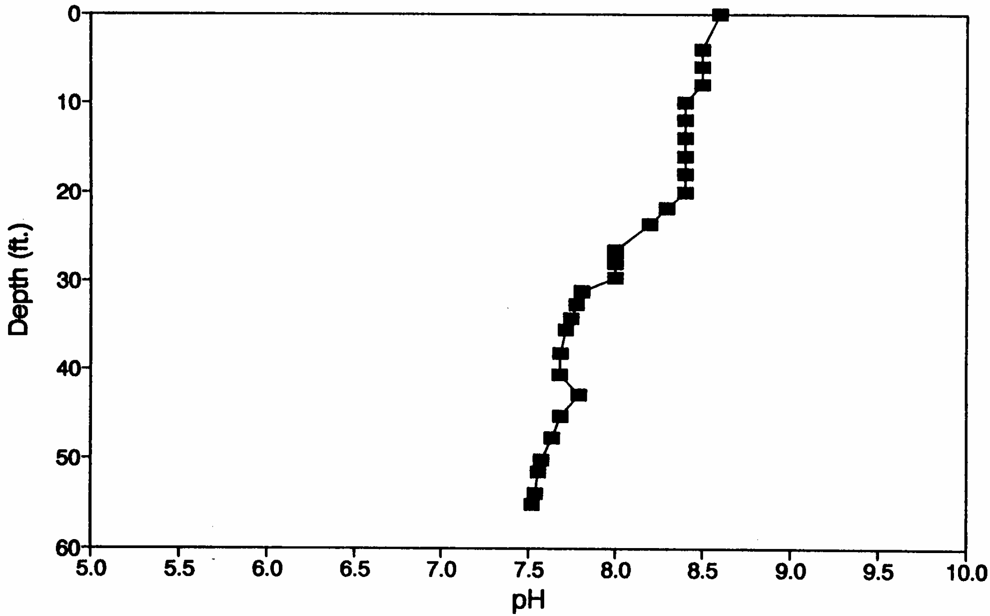


Figure 2c.

FISH LAKE pH PROFILE
June 20, 1990



indicate that Fish Lake was thermally stratified at the time of sampling, with the thermocline beginning between 12 and 14 feet.

Dissolved oxygen (DO) concentrations were between 7.84 and 5.20 mg/L from the surface to a depth of 14 feet. Oxygen levels began to drop to critical levels (i.e., <5.0 mg/L) between 16 and 30 feet. At 31 feet, the oxygen concentrations dropped sharply, with anoxic conditions from this depth to the lake bottom. The clinograde DO profile, as seen in Figure 2b, is generally indicative of productive, eutrophic lakes.

The pH distribution in the water column exhibited a pattern representative of a productive, stratified lake. pH values above the thermocline were higher than those below, ranging from 8.6 to 8.4. Below the thermocline, pH values ranged from 7.8 to 7.5. The higher pH values in the epilimnion (i.e., upper strata of water) are a result of the photosynthetic utilization of carbon dioxide (CO_2), a weak acid. As CO_2 is utilized and its concentration in the water column is reduced, pH increases.

Secchi depth is an expression of light transmittance through water, and is related to the natural light attenuation of the water being measured, the amount of inorganic suspended solids, and the amount of algal cells in the water column. The general assumption is that the greater the Secchi depth, the better the water quality of the lake. For northern temperate lakes, such as Fish Lake, a Secchi depth of 3 to 4 feet or less, during the summer growing season, is considered eutrophic (USEPA, 1988). The Secchi depth measured in Fish Lake was 1.75 meters, or 5.7 feet, which suggests that the lake was moderately eutrophic (mesotrophic) at the time of sampling.

3.2 CHEMICAL MEASUREMENTS

Water quality analyses were conducted on both in-lake and a baseflow tributary sample. Results for both types of samples collected are discussed below.

In-Lake Samples. The results of the water quality analyses for in-lake samples are presented in Table 3. Higher concentrations of TP and TKN were found in the bottom sample (51 ft.) than in the surface

Table 3. Fish Lake water quality results for in-lake and tributary samples.

SAMPLE ID	SAMPLE DEPTH (ft)	DATE COLLECTED	TIME COLLECTED	CHLa (mg/m^3)	TP (mg/L)	TKN (mg/L)
FL - SURFACE	0.0	06/20/90	10:55	8.0	0.068	1.8
FL - BOTTOM	51.0	06/20/90	11:10		0.085	2.2
FETCH DITCH		06/20/90	11:20		0.092	1.6

sample. An increase in nutrient concentration in lake bottom samples is to be expected as a result of both decomposition of organic material, and nutrient release from the lake sediments. Under anoxic conditions, the rate of nutrient release to the overlying water is accelerated, often resulting in nutrient concentrations that are many times greater at the lake bottom than at the surface. A relatively small increase in nutrient concentration (i.e., 25% and 22% for TP and TKN respectively) was measured in the Fish Lake bottom samples. This suggests that, despite anoxic conditions, the lake sediments were not a major contributor of nutrients to the lake at the time of sampling. Surface nutrient concentrations were moderately high and not indicative of extremely productive conditions, but rather of moderately eutrophic (i.e., mesotrophic) conditions.

The chlorophyll a concentration supports this assessment. A value of 8 mg/m^3 is indicative of moderately high numbers of phytoplankton, however, the number is still low enough to suggest that nutrient inputs to the lake were insufficient to produce nuisance algal blooms at that time. Utilization of nutrients by the macrophytes in the lake may have served to limit phytoplankton growth.

The calculation of a total nitrogen to total phosphorus ratio (N:P) is often used to evaluate the relative importance of these two algal nutrients. Both nitrogen and phosphorus are quickly taken up in their soluble forms (i.e. ortho-phosphate and nitrate). Thus, the concentrations of the soluble forms are not necessarily indicative of available supply (Welch, 1980). Additionally, algae are characteristically luxury consumers of phosphorus, taking up available phosphorus in excess of immediate physiological requirements. Nitrogen is rarely limiting in freshwater systems due to its abundance in the atmosphere and availability through nitrogen fixation by blue-green algae. The ratio of the total concentrations, however, can be used to assess which nutrient will be limiting to plant growth (i.e., the first to be used completely following continued growth) under optimal physical conditions where light and temperature are not inhibiting. Identifying this limiting nutrient is important in formulating management objectives for freshwater lakes.

As a general rule, if the N:P is 17 or greater, phosphorus is most likely the limiting nutrient. N:P ratios less than 13 are indicative of nitrogen limitation (Cooke, et. al., 1986). Either nitrogen or phosphorus may be limiting when ratios are between 13 and 17. The N:P ratios of the surface (26.5) and bottom (25.9) samples indicate that Fish Lake was phosphorus limited at the time of sampling.

Fetch Ditch. The results of the water quality analyses for Fetch Ditch are presented in Table 3. The TP concentration was higher in this tributary than in Fish Lake, while the TKN concentration was roughly equivalent to that found in the surface sample. These observations would indicate that Fetch Ditch is contributing to the nutrient loading of Fish Lake. The degree of contribution, however, cannot be determined from this data.

3.3 TROPHIC STATE ASSESSMENT

The biological, chemical and physical characteristics of a lake can be incorporated into an index number to describe its trophic state. A variety of trophic state indices are available to evaluate measured in-lake variables on a scale that allows a comparison of problems among lakes, as well as a comparison of a lake's status over a period of time. Additionally, the use of a trophic state index provides a quantitative means of assessing lake changes after restoration practices have been implemented.

One of the most widely used trophic state indices is the Carlson Trophic State Index (TSI). Carlson (1977) based his index on algal biomass, using the log transformation of Secchi disk transparency as an estimate of biomass. Since Chla and TP concentrations are often correlated with transparency, a TSI number may also be calculated from these biological and chemical measurements. All three measurements are taken from surface waters where phytoplankton productivity is at its peak.

The basis for the trophic state index concept is that the degree of eutrophication in a lake is believed to be related to an increase in nutrient concentrations. An increase in nutrient (i.e., phosphorus) concentration is expected to cause in an increase in algal biomass as measured by Chla. The increase in algal biomass would then coincide with a decrease in water transparency as measured by Secchi disk.

The Carlson TSI classifies lakes on a scale of 0 to 100, with each major scale division (i.e., 10, 20, 30,...) representing a doubling in algal biomass. Under ideal circumstances, the three separate TSI values should be similar, however, the index values will exhibit some variability. It is this variability that reveals the basic differences in the ecological functioning of the aquatic system. The accuracy of Carlson's TSI based on Secchi disk measurement alone is diminished by the presence of non-algal particulate matter or highly colored water. The index number derived by the Chla values, when available, is best for estimating algal biomass, and priority should be given for its use as a trophic state indicator (Carlson, 1977).

Calculation of the Carlson TSI for Fish Lake was based on the Chla and TP concentrations in the surface water, as well as the Secchi disk transparency. Table 4 presents the results of these calculations. The range of TSI values was between 51 and 65. Lakes with TSI numbers between 50 and 60 are

Table 4. Carlson Trophic State Index calculations for Fish Lake.

SAMPLE DATE	SECCHI DISK (m)	TSI (SD)	CHLOROPHYLL (mg/m^3)	TSI (CHLa)	TP (mg/m^3)	TSI (TP)
06/20/90	1.75	52	8.0	51	68	65

characterized by decreased water transparency, increased macrophyte growth, and anoxic hypolimnia during the warmer summer months. These lakes are beginning to experience accelerated eutrophication. As TSI values increase into the 60 to 70 range, blue-green algae become dominant and algal scums are probable (Carlson, 1979). A comparison of the calculated TSI values shows that the Secchi disk and Chla based values are nearly equivalent. This would indicate that algae dominate light attenuation.

Overall, the Carlson TSI classifies Fish Lake as moderately eutrophic at the time of sampling. It should be noted that the data used to construct this index are derived from a single sampling event and are only representative of lake conditions on a single day in late June. Better representation of trophic state could be attained through increased lake monitoring throughout the summer growing season.

3.4 AQUATIC VEGETATION

During the field survey, macrophyte beds were observed along the shoreline of the lake. Dense stands of white water lily (Nymphaea odorata), spatterdock (Nuphar advena), and cattail (Typha latifolia) were noted near the lake outlet. Water milfoil (Myriophyllum spicatum) and a pondweed species (Potamogeton sp.) were observed in the shallower, southern portion of the lake. The northwest side of the lake exhibited moderately heavy beds of another pondweed species which extended around the northern end of the lake to the northeast shore area. Additionally, duckweed (Lemna minor) was observed on the northeast side of the lake, in the vicinity of the second intermittent tributary.

3.5 WATERSHED SURVEY

The visual reconnaissance of the Fish Lake watershed revealed that the majority of the land is used for agricultural purposes. Row crop agriculture, and hog and cattle farming appear to be the major farming enterprises. Row crop agriculture is dominant in lands north, west, and southeast of Fish Lake. Wooded acreage is dominant along the northeast shore.

Fetch Ditch begins in a wetland area on the west side of C.R. 1000 West, just south of State Road 120. The water course flows in a northerly direction, through several fields and animal operations, prior to crossing under the Indiana Toll Road (Interstate 80). After the Toll Road, the ditch continues in a northeasterly direction, through an area of row crop agriculture (i.e., primarily corn) to Fish Lake. The banks of the ditch from C.R. 750 North to Fish Lake are heavily wooded. Potential sources of nutrient and sediment loading within the Fetch Ditch watershed include several hog and cattle operations, runoff from the Indiana Toll Road, and the acreage dedicated to row crop agriculture.

SECTION 4. RECOMMENDATIONS

Based on the limited amount of data collected for this survey, the problems observed in Fish Lake appear to stem from nutrient enrichment and associated sediment loading. Although nutrients may be contributed as a result of near-shore activities, watershed inputs largely determine both in-lake nutrient concentrations and sedimentation rates in most lakes. The most effective strategy for restoring a lake begins with the implementation of best management practices (BMP's) in the watershed. Water quality improvement due to watershed BMP implementation is a gradual process that may take place over a period of several years. In the interim, in-lake restoration strategies represent viable options for immediate improvement in the condition of the lake.

4.1 IN-LAKE TREATMENT

The recommended in-lake restoration strategy is directed at the control of nuisance growths of aquatic vegetation, per the request of the Association. Although plant growth has not reached nuisance levels in 1990 (P. Wysong, pers. comm., Michiana Fish Lake Association, 1990), the recommended treatment technique for future reference is mechanical weed harvesting.

Mechanical weed harvesting is a procedure by which nuisance growths of rooted vegetation and associated filamentous algae are cut and removed from the lake. The most common means of harvesting is accomplished through the use of a mechanical weed harvester; a maneuverable, low-draft barge designed with one horizontal and two vertical cutter bars, a conveyor to remove cut plants to a holding area on the machine, and another conveyor to rapidly unload plants. Disposal of the cut materials is usually not a problem. Because aquatic plants are more than 90% water, their dry bulk is comparatively small. Additionally, farmers and lakeshore residents will often use the cut weeds as mulch and fertilizer.

Most harvesting operations are successful in producing at least temporary relief from nuisance plants. This relief, however, is dependent on plant regrowth which, in some cases, may occur within a period of days or weeks (USEPA, 1988). The direct benefits of aquatic plant harvesting relate primarily to increased recreational use of the lake. Nutrient removal, and protection of the pelagic zone from nutrient release during macrophyte decay may also result from harvesting. Weed harvesting, however, is energy and labor intensive. Additionally, plants may fragment and spread the infestation. It is recommended that floating barrier systems by utilized during harvesting to curtail the spread of buoyant plant fragments, and aid in their collection.

As a cautionary note, over-harvesting of aquatic weeds will result in a shift from the dominance of macrophytes to an algae dominated system. Given the beneficial aspects of aquatic weeds in terms of fisheries habitat, and the detrimental aspects of algal dominance (i.e., fish kills, decreased water clarity, and taste and odor problems), maintenance of well developed weed beds should be a management objective. Harvesting should be aimed at improving and maintaining access to the lake, but not at eradication of existing weedbeds.

4.2 LAKE SHORE MAINTENANCE

4.2.1 Lawn Maintenance

No data were collected during this survey to indicate a problem specific to homeowner lake shore maintenance, however the following "common sense" procedures will minimize the nutrient concentration in runoff from lake shore property.

Grass clippings should be allowed to remain on the lawn following mowing unless excessive thatch build-up occurs. This will reduce the need for artificial nutrients. Raked leaves should not be disposed of in or near the lake or its tributaries. Instead, they should be bagged and transported to a compost area away from any water flow path. If a compost area is used, runoff should not be allowed to reach the lake or tributaries, as this would contribute to the nutrient load to Fish Lake.

Applications of lawn fertilizers should be avoided or minimized at best. These products will not only enhance the growth of the lawn, but also the growth of algae and macrophytes in the lake if they are present in runoff. If it is necessary to use lawn chemicals, a buffer strip of lawn area, abutting the lake shore, should be left untreated to filter the runoff prior to its reaching the lake.

4.2.2 Septic Systems

Homes on septic systems within the watershed, and more importantly, on the lake shore, may be a source of nutrients. No data were collected during this survey to indicate this, however the following paragraphs offer general guidance on installation, use, and maintenance of septic systems.

Septic systems should be installed in appropriate soil types, with an adequate buffer distance between leach fields and lake/tributary systems. Both the Soil Conservation Service (SCS) and the U.S. Geological Survey (USGS) have information pertaining the soil suitability and geologies for drain field construction. Additionally, the local health department or appropriate state agency should be contacted concerning the most recent legal guidelines on septic system installation.

To ensure adequate capacity for peak use periods and implement proper maintenance routines, the septic tank should be inspected yearly to assess the rate of solids accumulation. Periodic septic tank pump-out will prolong the life of the system. Material removed from the tank should be discharged at a wastewater treatment plant. Additionally, trees should not be allowed to grow on top of the drain field, as the roots can penetrate the field and diminish its efficiency.

4.3 VOLUNTEER LAKE MONITORING PROGRAM

A long-term water quality monitoring program would provide a basis for detecting changes in the water quality of Fish Lake. The objective of such a program would be to assess the condition of the lake, over time, and draw conclusions regarding future changes that may be observed. Additionally, if a decline in water quality should occur, and the causes are not immediately evident, the data collected under this program would provide the level of detail needed for a professional lake manager to analyze the situation.

A monitoring program could be implemented for Fish Lake using volunteers from the Michiana Fish Lake Association. A similar volunteer program is currently underway at Shipshewana Lake in LaGrange County, Indiana. This section describes the basic components of a monitoring program that could be conducted by volunteers, with assistance from a local analytical laboratory.

4.3.1 Data Collection

The core of a monitoring program is the routine collection of water quality measurements. The collection of storm flow samples from the tributaries to the lake is also recommended, however, this would be a more difficult task given the unpredictability of sampling frequency.

Water quality monitoring should include both in-situ (i.e., in-lake) measurements and laboratory analyses of water samples. In-lake measurements and samples should be collected from a single station at the deepest location in the lake. These measurements should be collected on a regular basis, such as the first and third Monday of each month. In-situ measurements should include Secchi disk transparency, and temperature and dissolved oxygen profiles. The instrumentation required for these measurements may be purchased for between $850 and $1,000.

Water quality samples should be collected at the surface, mid-depth and approximately one foot above the bottom of the lake. Samples should be analyzed for total phosphorus, total nitrogen and chlorophyll a. A suitable Van Dorn-type water sampler may be purchased for approximately $400. Analytical costs will be dependent on the laboratory used. To minimize costs it is recommended that a local health department laboratory be utilized, if possible.

Because sediment and nutrient loading is an issue of concern, a basic program of tributary storm sampling is recommended. A single, large storm event may produce a nutrient income equivalent to several months of income during normal flow. In sampling storm runoff, there is a compromise between the ideal, which would involve flow-weighted samples collected throughout each storm event, and the practical constraints of limited funds to support the program. Because flow-weighted sampling is expensive and labor intensive, manual collection of grab samples from the tributaries is recommended. The consistent collection of many grab samples over a period of time can provide a basis for comparison among tributaries and detection of large changes in loading through time.

Collection of storm flow samples should be at, or just before the peak flow in each tributary. Storm samples should be analyzed for total suspended solids, total phosphorus and total nitrogen.

4.3.2 Data Management

A single individual, or small group of individuals, should be responsible for all data collection and records maintenance to ensure that monitoring is conducted reliably and consistently. Consistency of technique and analytical methods is essential to minimize random variability in the data and maximize the value of the collected information in detecting changes over time.

Standardized data forms should be developed and used for all field measurements and sample collection. Both the in-situ data and the results from the analytical laboratory should be entered into a PC-based database. There are numerous software packages available that provide the necessary features for ease of maintenance, statistical analyses, and graphics.

4.3.3 Data Interpretation

The data generated by this program will provide a general characterization of Fish Lake. There are some simple methods for presenting the data that will allow local lake managers to utilize the data and draw some basic conclusions.

Graphic plots of the water quality data should be maintained as a basic interpretive tool. Water quality time-series data plots can be used to visually detect seasonal trends, long-term trends, and differences in extreme values between years.

Water quality parameters may be evaluated in terms of annual statistics. A simple example would be the examination of the average annual Secchi disk transparency along with the range of transparencies observed during the year. A trend of decreasing annual means and minimum transparencies would suggest that either suspended sediment or algae concentrations are increasing. Additionally, the Carlson Trophic State Index (TSI) could be applied to the monthly water quality data collected on the lake. A more representative trophic state assessment could be obtained by examination of the TSI values observed over a period of time. A good limnological text, such as Wetzel (1983) will provide more detailed interpretive guidance than can be provided within the scope of this investigation.

4.4 STATE ASSISTANCE

Due to the unique geographical setting of Fish Lake, both Michigan and Indiana state agencies should be contacted regarding financial assistance for lake and watershed restoration measures.

The Indiana Department of Natural Resources, Division of Soil Conservation, administers the "T by 2000" program. This is a comprehensive, state-funded program aimed at significantly reducing soil erosion and sedimentation throughout Indiana within a definite time period. The program is carried out at the local level through the county Soil and Water Conservation Districts (SWCDs). One component of the "T by 2000" program is the Lake Enhancement Program (LEP). The LEP is designed to provide technical and financial help to control sediment and associated nutrient problems in public-access lakes. Qualified projects must examine not only the lake proper and/or its tributaries, but also the surrounding watershed where significant sediment and nutrient sources are identified and control strategies recommended.

Funding request for lake enhancement projects are made by local entities, such as a lake association, planning organization, or governmental unit. The monies granted to qualified projects must be used for either (1) feasibility studies, (2) design plans, or (3) construction actions. In the case of Fish Lake, a feasibility study would be warranted to fully characterize the lake and surrounding watershed, identify nutrient and sediment related problems, and present and recommend the most appropriate mitigative strategy. Additional information concerning lake enhancement financial assistance can be obtained from the LaGrange County Soil and Water Conservation District office, or from the LEP staff in West Lafayette, IN. Lake enhancement personnel may be contacted by phone at (317) 494-8383.

The Michigan Department of Natural Resources, Division of Land and Water Management, administers both regulatory and public assistance programs dealing with specific lakes, and broad lake issues, through their Inland Lake Management Unit (ILMU). Elements of the ILMU program include providing information on macrophyte and algae control, issuing permits for herbicide use, interacting with private consultants on lake restoration/management projects, administration of the Inland Lake Self-help Monitoring Program, and providing technical assistance to local Lake Improvement Boards. Lake Improvement Boards are comprised of representatives from local units of government and property owners with a viable interest in improving the overall quality of a particular lake or lakes. The Board operates as the sponsoring entity for a local lake restoration/management project. Additional information concerning this program, and the role of Lake Improvement Boards, can be obtained from the IDNR, Div. of Land and Water Management in Lansing, Michigan. The ILMU staff may be contacted by phone at (517) 373-8000.

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